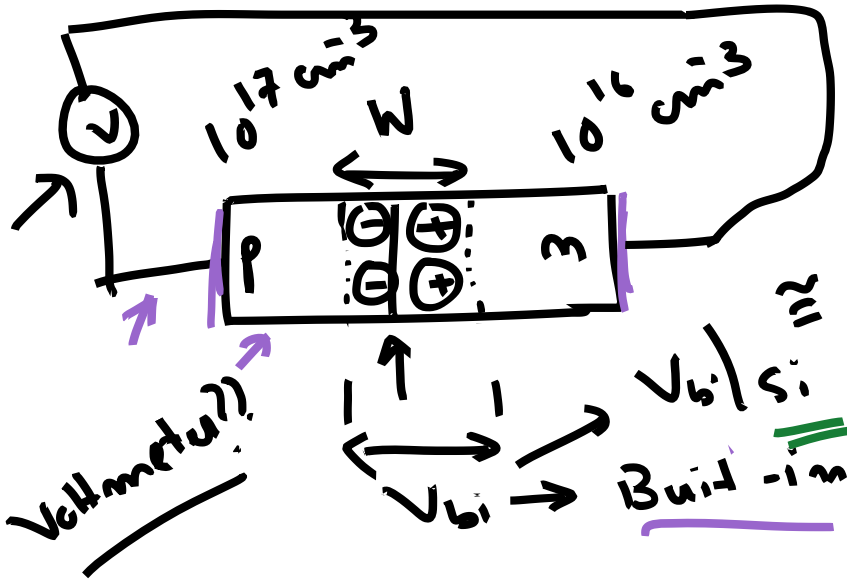
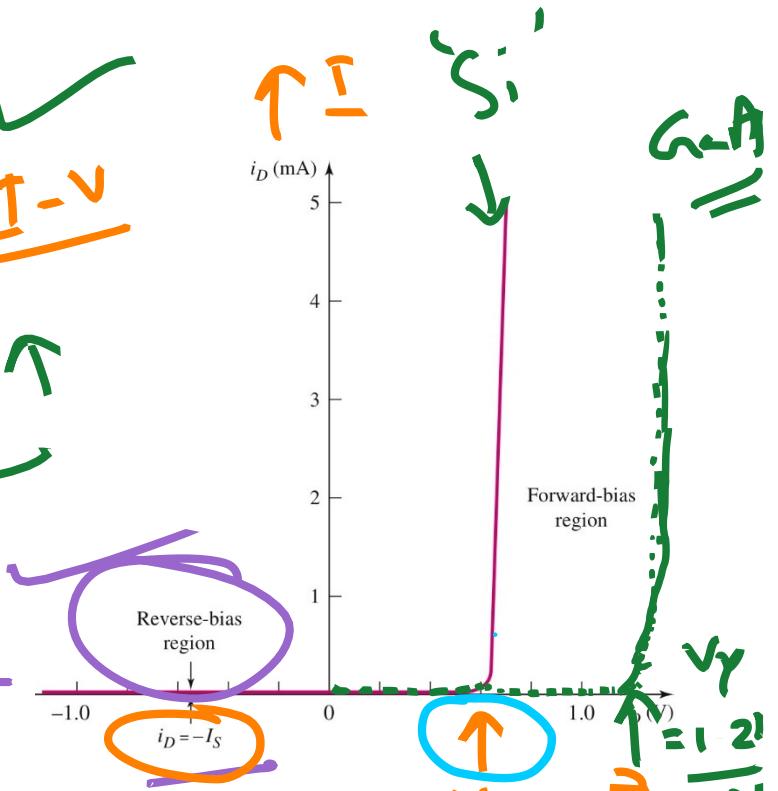
Recap





* E_g ↑, V_{bi} ↑, V_γ ↑

E_g ↑

GaAs → V_{bi} → 1.22 V

I-V expression

$I = I_S \left[\exp\left(\frac{V}{nV_T}\right) - 1\right]$; $n = 1$, $V > 3V_T$

$I = I_S \exp\left(\frac{V}{V_T}\right)$; V increases by $\exp\left(\frac{60}{26}\right) \approx 10$

1V = 1000 mV

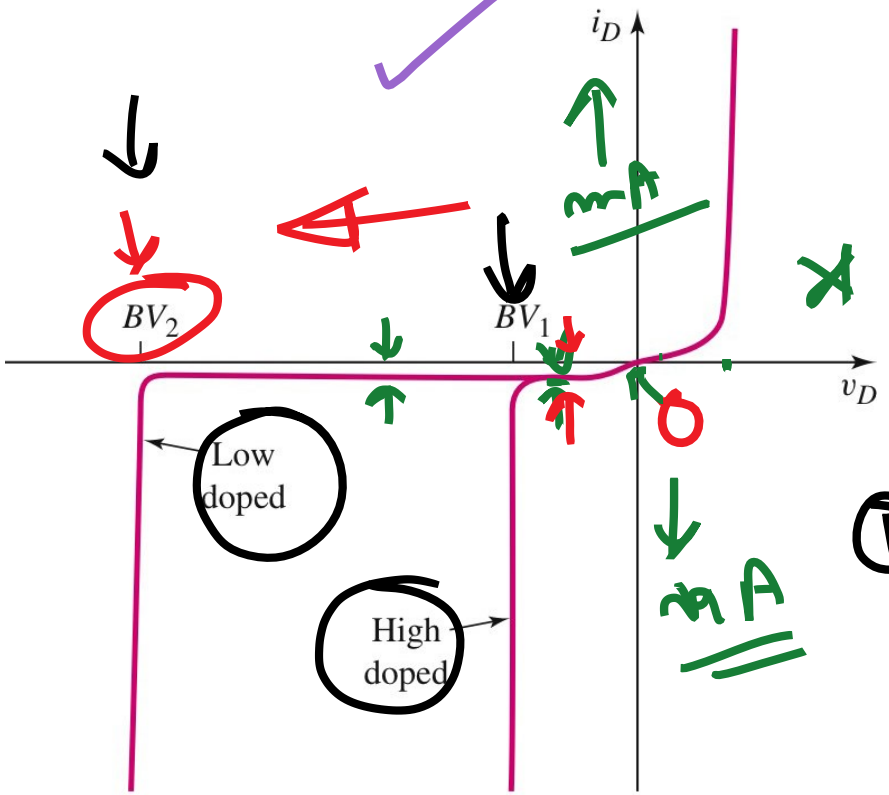
60 mV

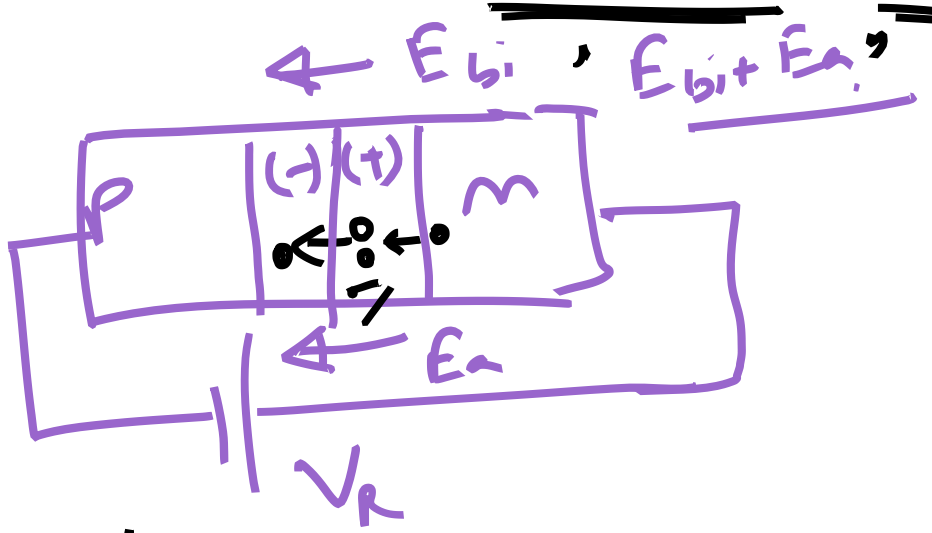
I ??

current of p-n junction increases by * 10 times

Source: Electronic circuits: Analysis and Design –by D. A. Neamen, McGraw-Hill

Breakdown characteristics of p-n junction diode





① Avalanche Breakdown

② Zener Breakdown → tunneling of carriers

→ heavily doped

Source: Electronic circuits: Analysis and Design –by D. A. Neamen, McGraw-Hill

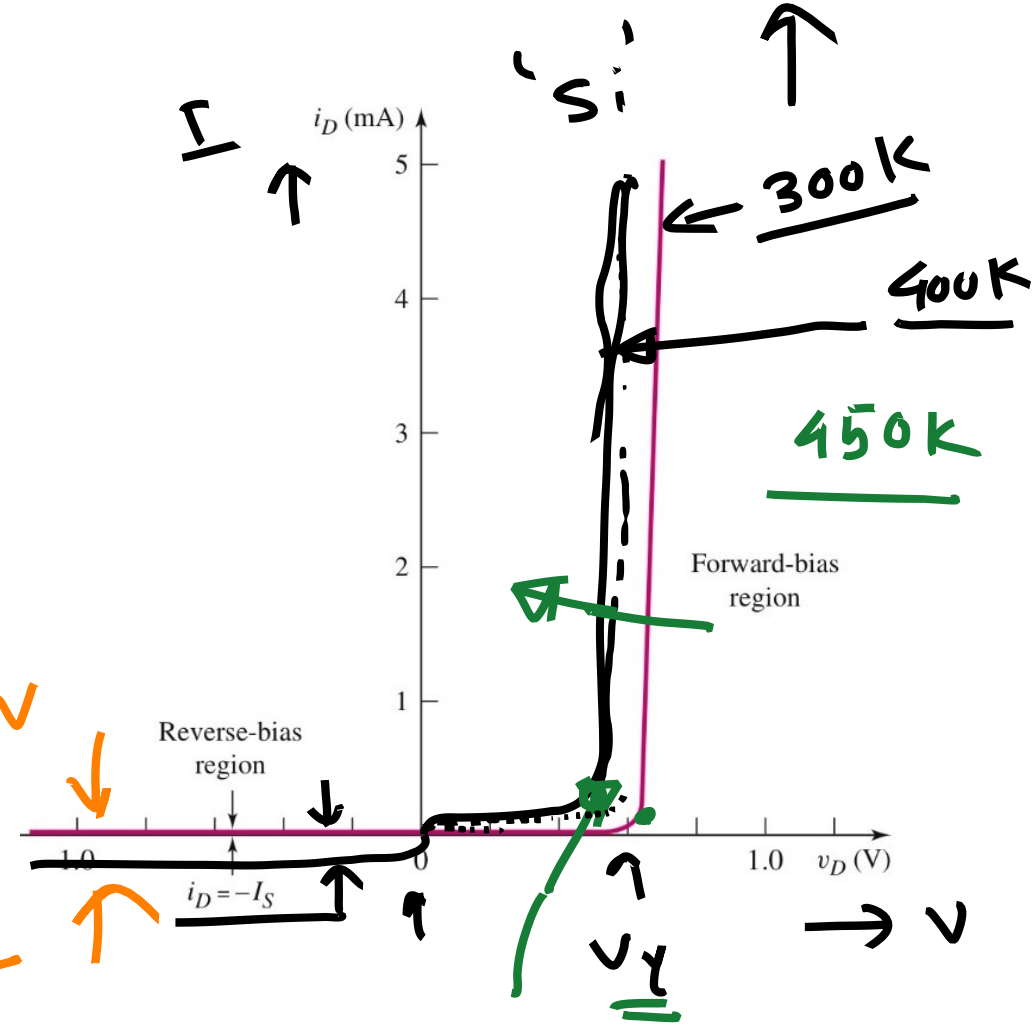
Effect of Temperature on diode characteristics (I-V)

$$I_S = Aq\left(\frac{D_n}{L_n}\frac{n_i^2}{N_A} + \frac{D_p}{L_p}\cdot\frac{n_i^2}{N_D}\right)$$

$I_S \propto n_i^2$

$n_i \propto \exp(T)$

$T\uparrow,\ n_i\uparrow,\ I_S,\ I_D = I_S \exp\left(\frac{V}{V_T}\right)\uparrow$



Si → 1.1 eV

Ge → 0.66 eV

"Eg" on I_S

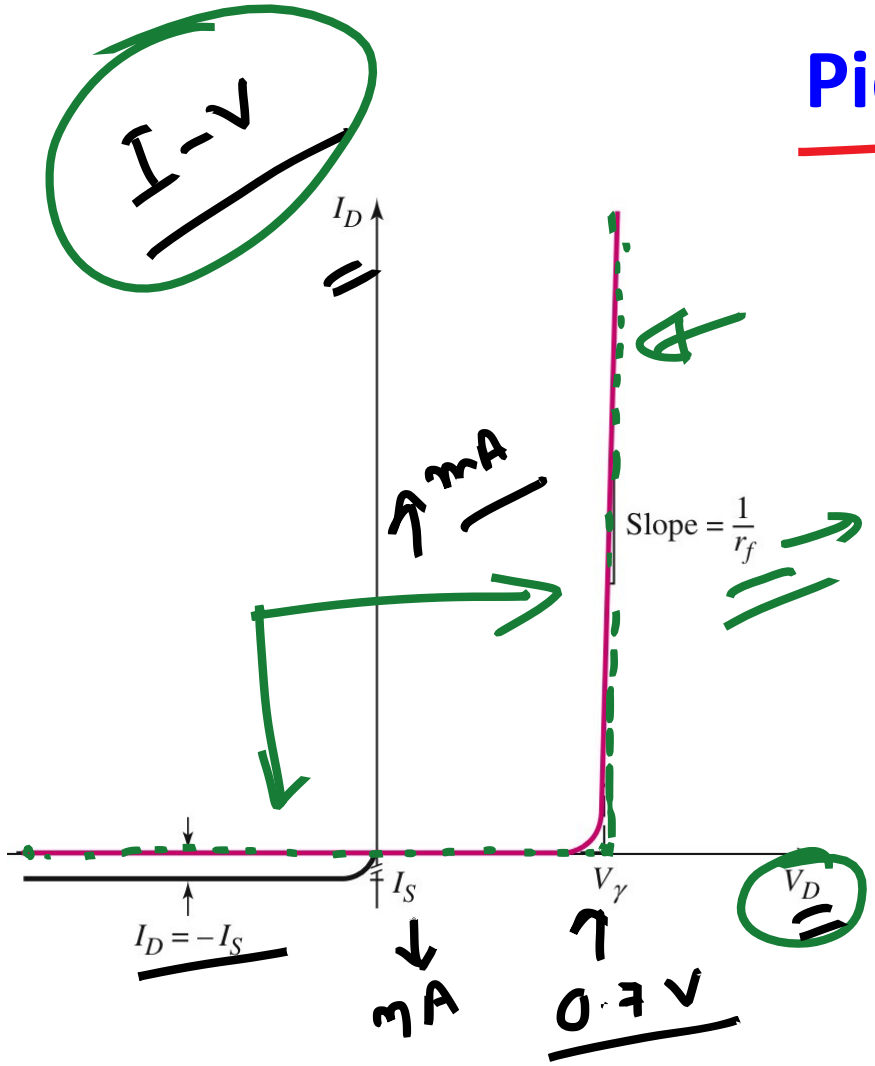
$E_g\downarrow,\ n_i\uparrow,\ I_S\uparrow$

Every 10°C rise in T, I_S doubles

New V_γ at 400K

Source: Electronic circuits: Analysis and Design –by D. A. Neamen, McGraw-Hill

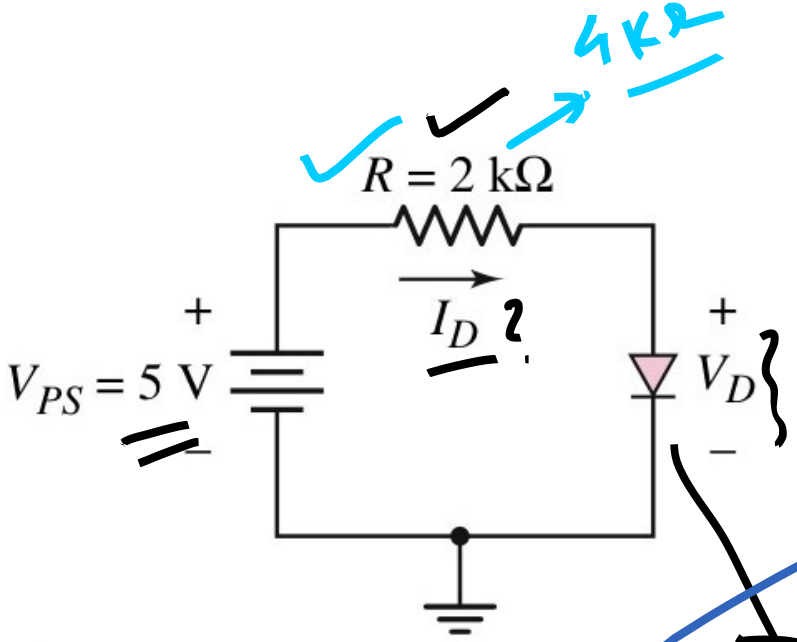
Piecewise Linear Model

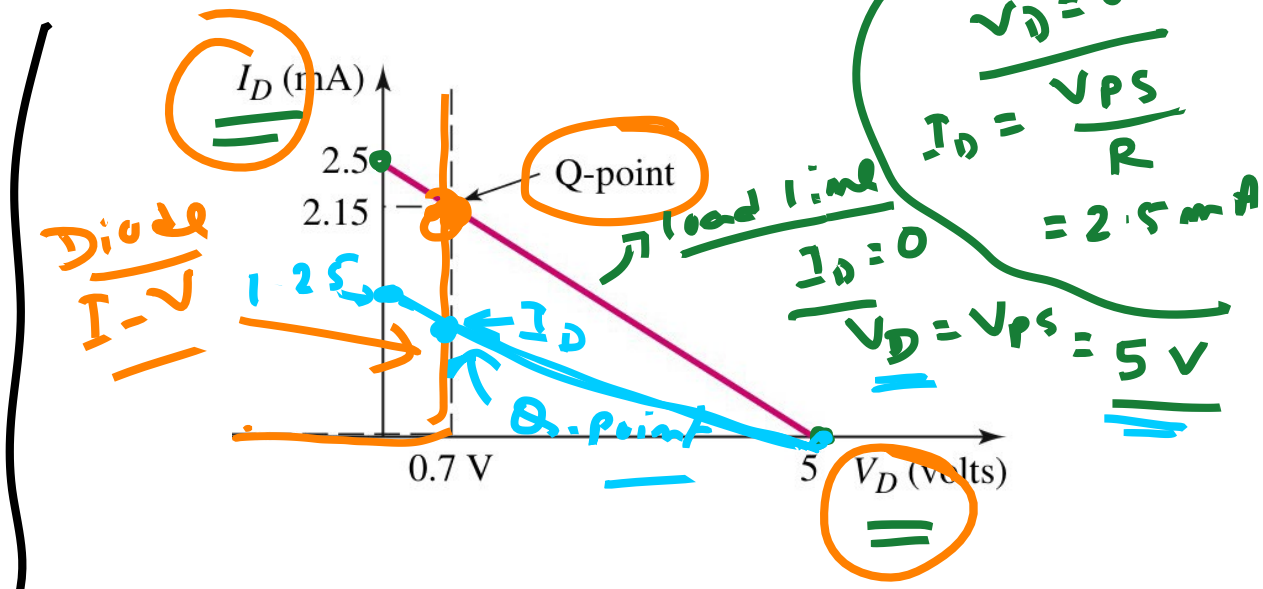


Two linear approximations are used to form piecewise linear model of diode.

Source: Electronic circuits: Analysis and Design –by D. A. Neamen, McGraw-Hill

A simple diode circuit



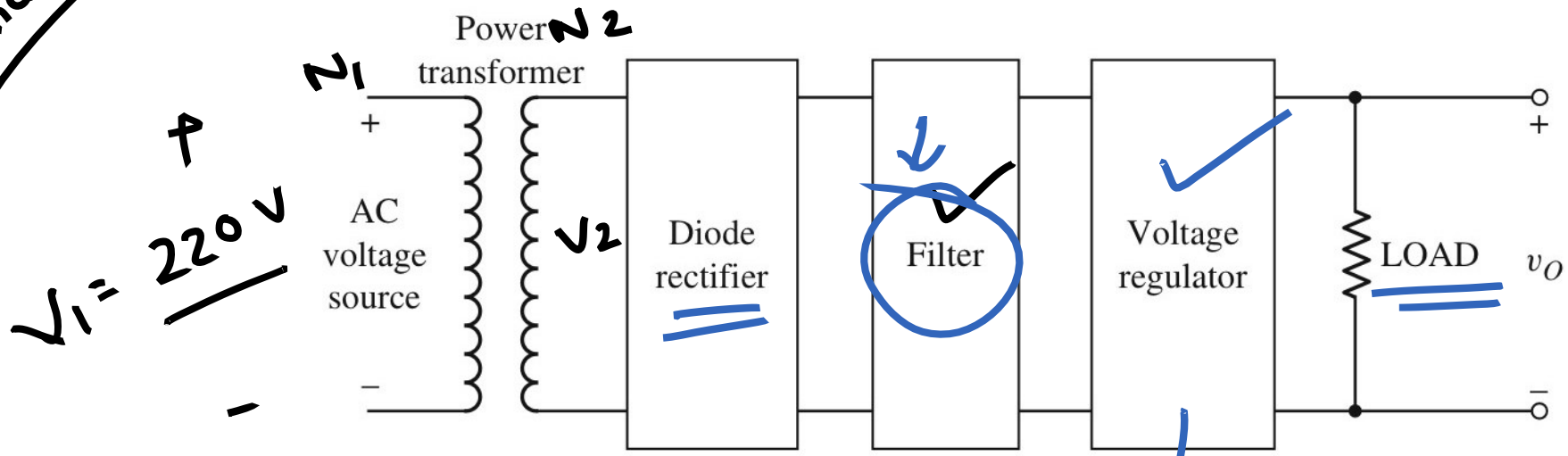


- The x intercept of the load line is the open circuit voltage and the y intercept is the short circuit current.
- The Q-point is dependent on the power supply voltage and the resistance of the rest of the circuit as well as on the diode I-V characteristics.

Source: Electronic circuits: Analysis and Design –by D. A. Neamen, McGraw-Hill

AC to DC converter

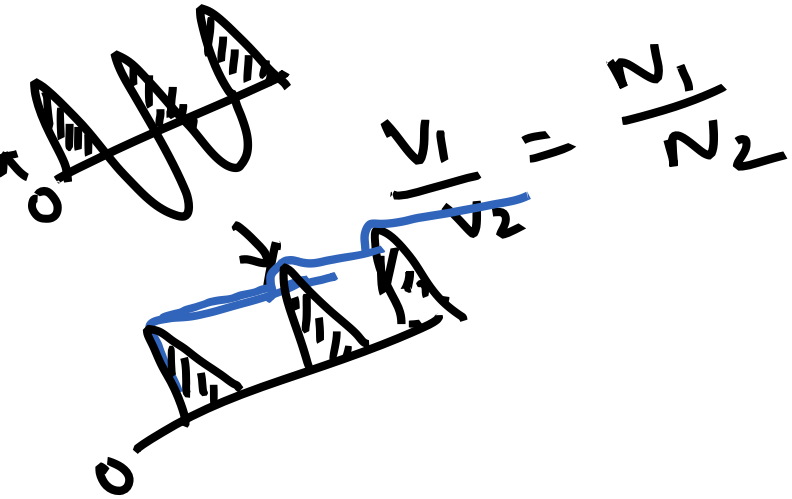
Application → Mobile, Laptop



$V_1 = 220\ V$

$\frac{V_1}{V_2} = \frac{N_1}{N_2}$

* Zener diode



Source: Electronic circuits: Analysis and Design –by D. A. Neamen, McGraw-Hill